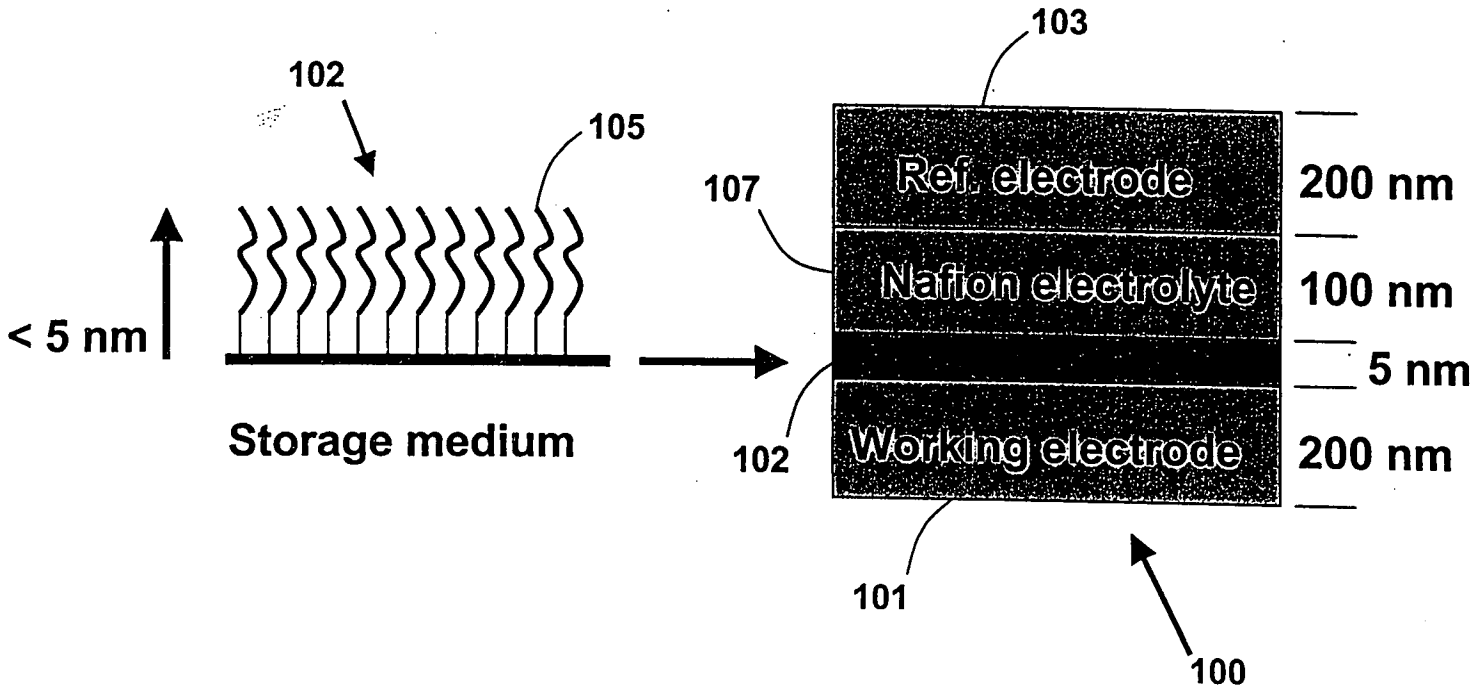

102
105
< 5 nm
Storage medium
103
107
Ref. electrode
Nafion electrolyte
Working electrode
200 nm
100 nm
5 nm
200 nm
102
101
100

Fig. 1

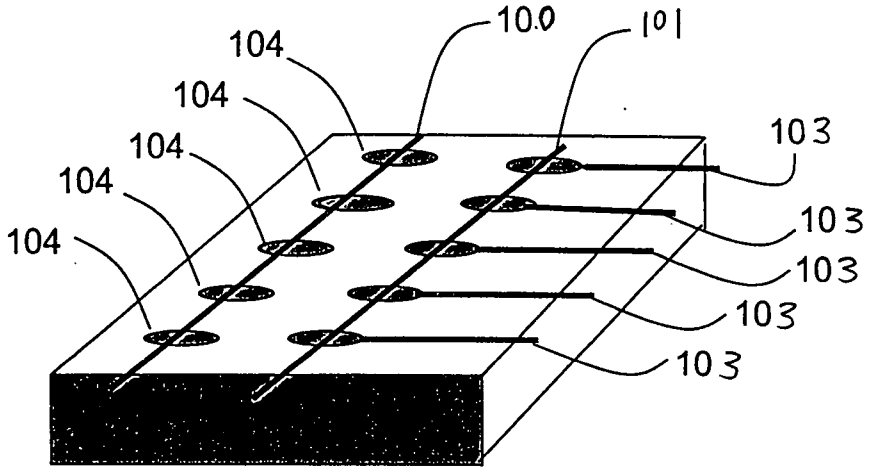


Fig. 2

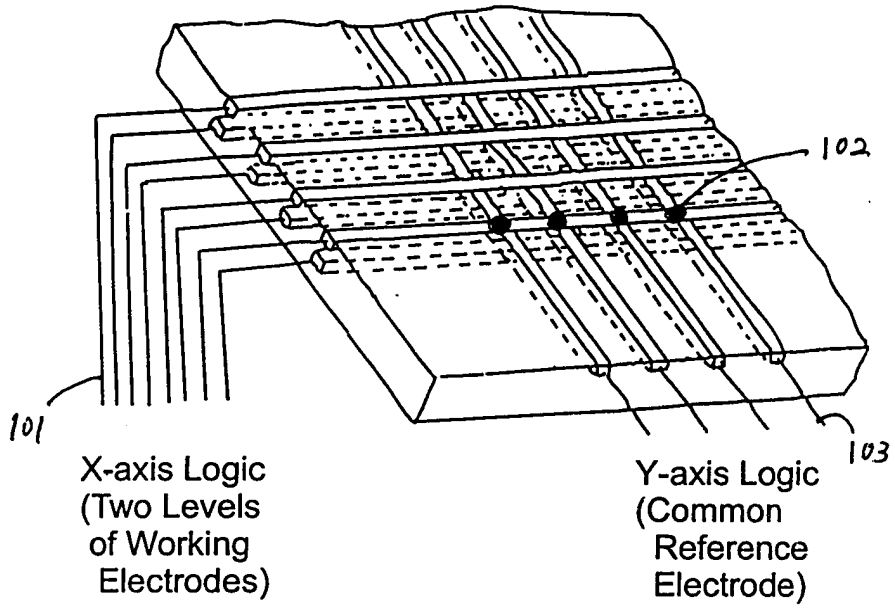

102
101
103
X-axis Logic
(Two Levels
of Working
Electrodes)
Y-axis Logic
(Common
Reference
Electrode)

Fig. 3

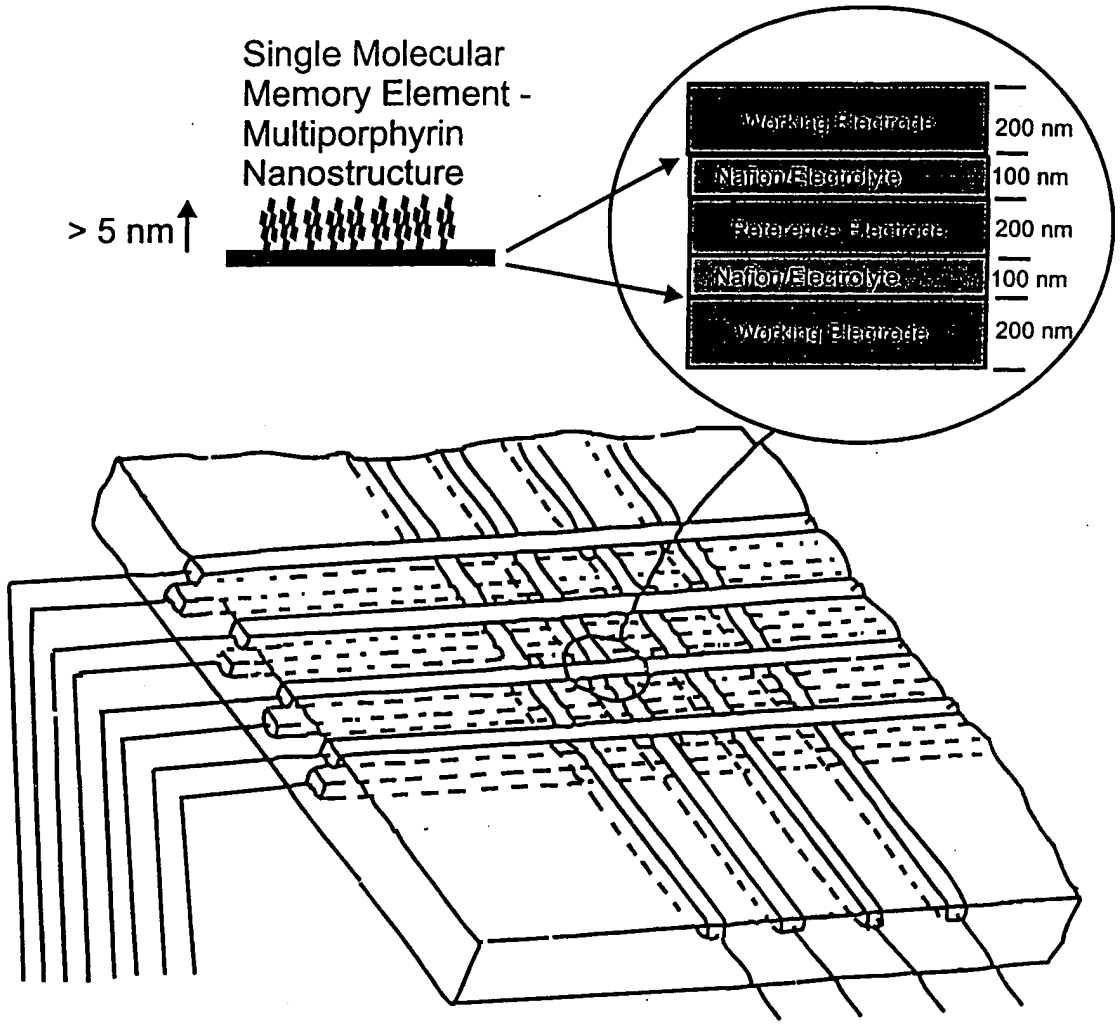

Single Molecular
Memory Element -
Multiporphyrin
Nanostructure
> 5 nm
Working Electrode
Nafion/Electrolyte
Reference Electrode
Nafion/Electrolyte
Working Electrode
200 nm
100 nm
200 nm
100 nm
200 nm
X-axis Logic
(Two Levels
of Working
Electrodes)
Y-axis Logic
(Common
Reference
Electrode)

Fig. 4

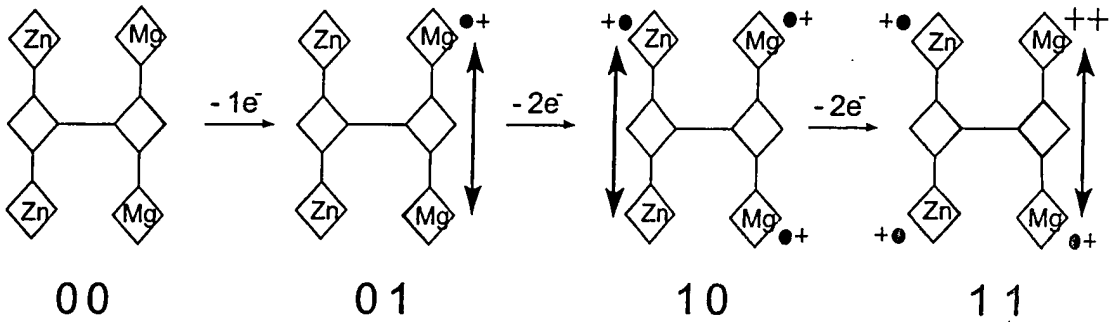


Fig. 5

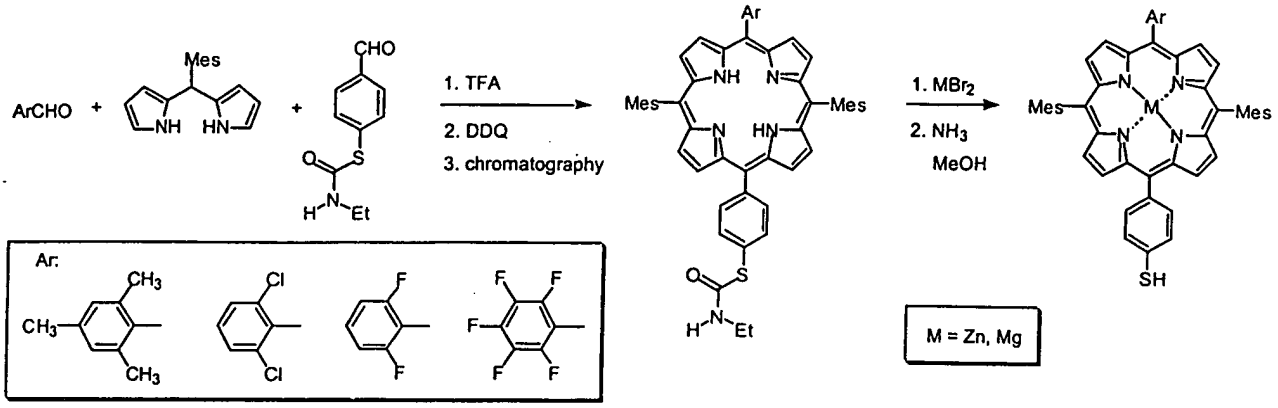

ArCHO
Mes
NH
HN
CHO
S
O
H
N
Et
1. TFA
2. DDQ
3. chromatography
Ar
Mes
Mes
1. MBr2
2. NH3
MeOH
M
SH
Ar:
CH3
CH3
CH3
Cl
Cl
F
F
F
F
F
F
M = Zn, Mg

Fig. 6

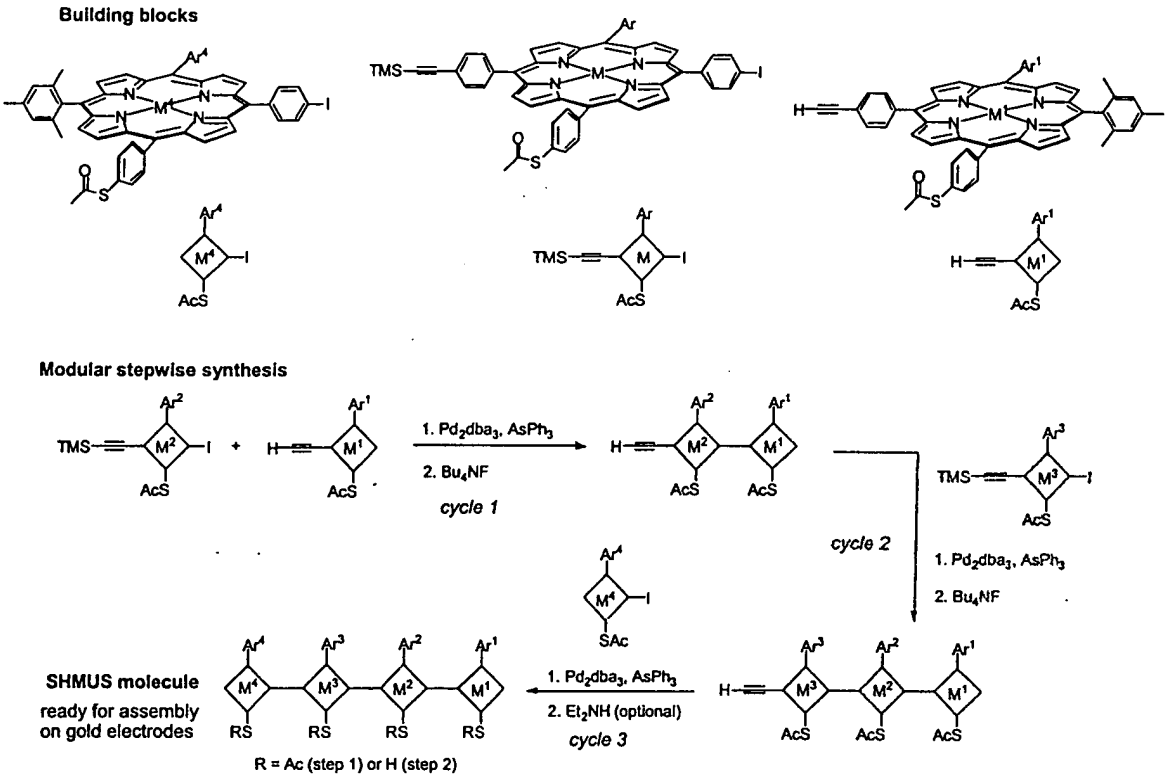

Building blocks
Modular stepwise synthesis
1. Pd2dba3, AsPh3
2. Bu4NF
cycle 1
cycle 2
1. Pd2dba3, AsPh3
2. Bu4NF
1. Pd2dba3, AsPh3
2. Et2NH (optional)
cycle 3
SHMUS molecule
ready for assembly
on gold electrodes
R = Ac (step 1) or H (step 2)

Fig. 7

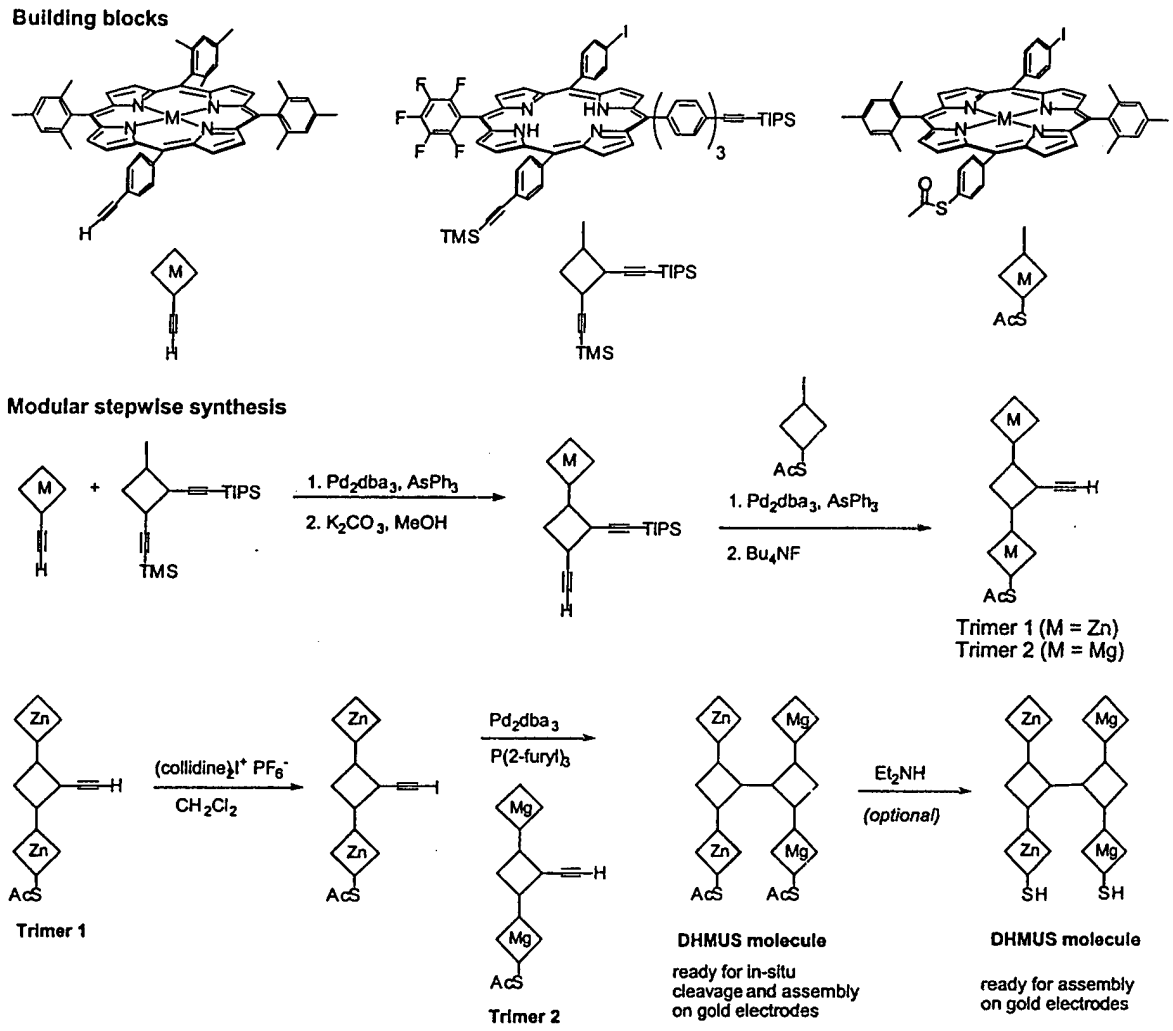

Building blocks
Modular stepwise synthesis
1. Pd2dba3, AsPh3
2. K2CO3, MeOH
1. Pd2dba3, AsPh3
2. Bu4NF
Trimer 1 (M = Zn)
Trimer 2 (M = Mg)
(collidine)2I+ PF6-
CH2Cl2
Pd2dba3
P(2-furyl)3
Et2NH
(optional)
Trimer 1
Trimer 2
DHMUS molecule
ready for in-situ cleavage and assembly on gold electrodes
DHMUS molecule
ready for assembly on gold electrodes

Fig. 8

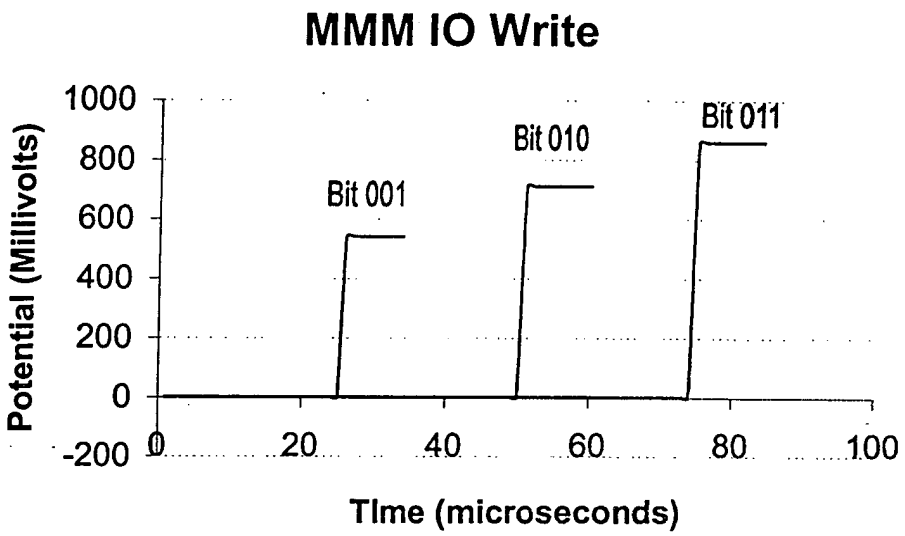

MMM IO Write
1000
800
600
400
200
0
-200
Potential (Millivolts)
Bit 001
Bit 010
Bit 011
0
20
40
60
80
100
TIme (microseconds)

Fig. 9

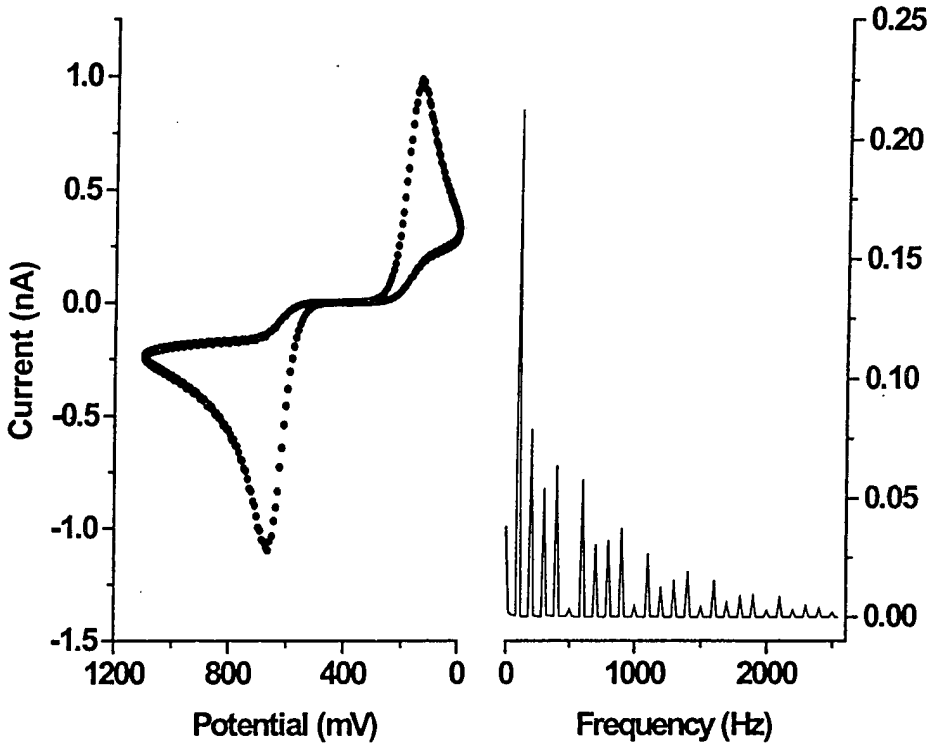

1.0
0.5
0.0
-0.5
-1.0
-1.5
Current (nA)
1200
800
400
0
Potential (mV)
0.25
0.20
0.15
0.10
0.05
0.00
0
1000
2000
Frequency (Hz)

Fig. 10

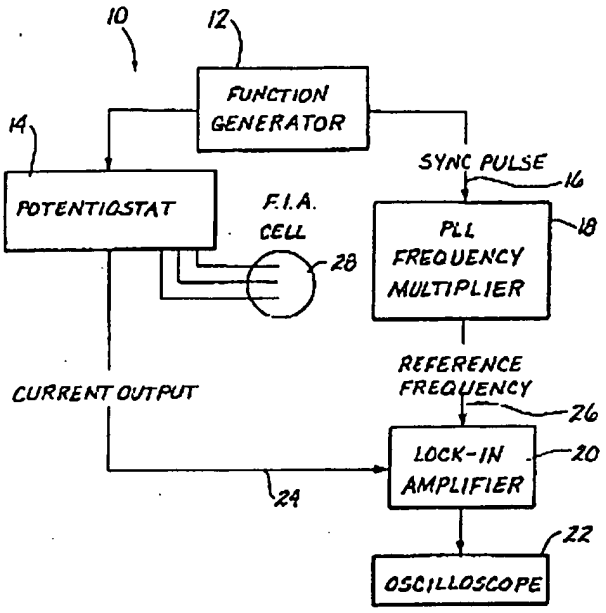

10
12
FUNCTION GENERATOR
14
POTENTIOSTAT
F.I.A. CELL
28
SYNC PULSE
16
PLL FREQUENCY MULTIPLIER
18
REFERENCE FREQUENCY
26
CURRENT OUTPUT
LOCK-IN AMPLIFIER
20
24
22
OSCILLOSCOPE

Fig. 11

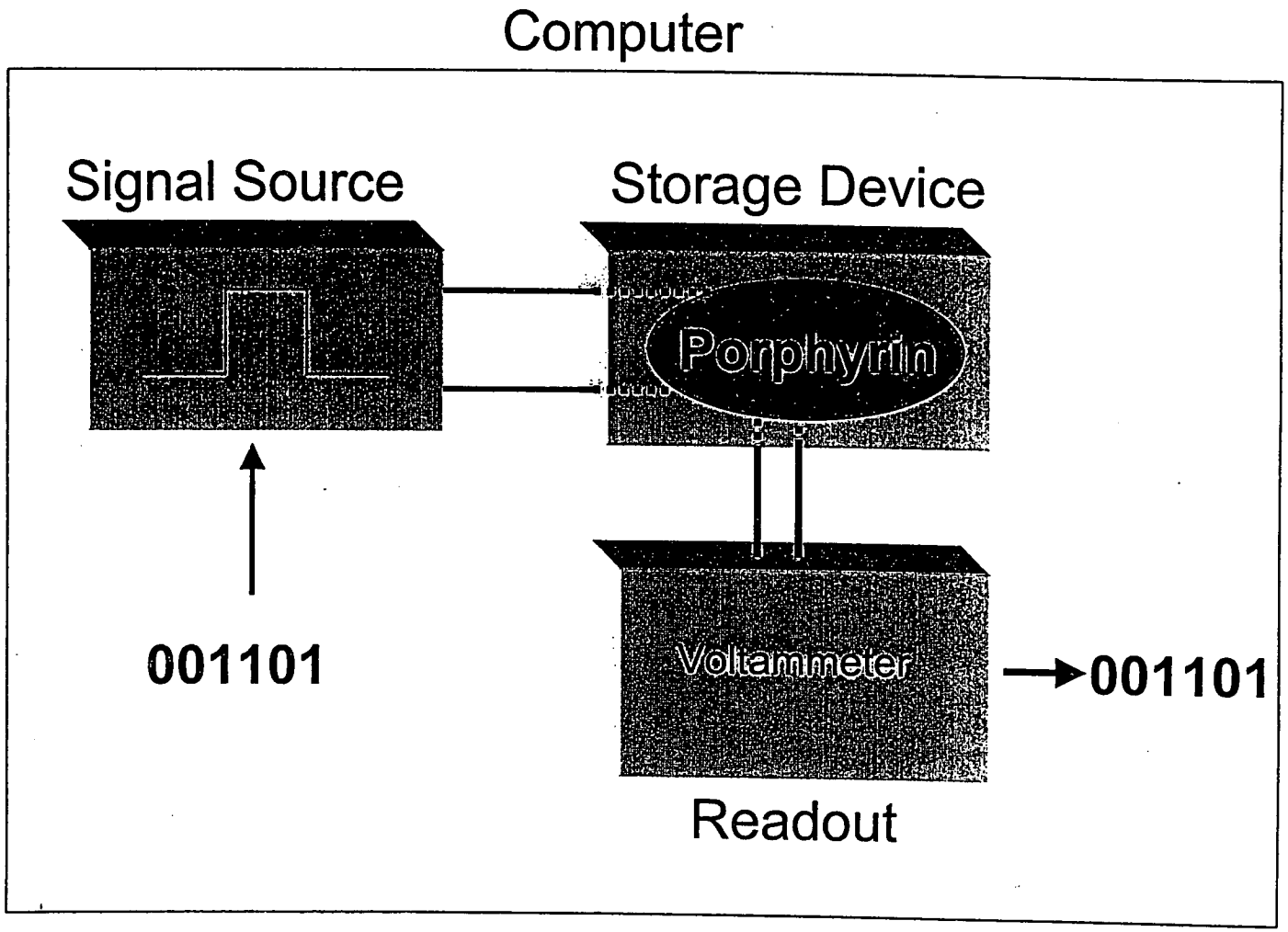

Computer
Signal Source
Storage Device
Porphyrin
001101
Voltammeter
001101
Readout

Fig. 12

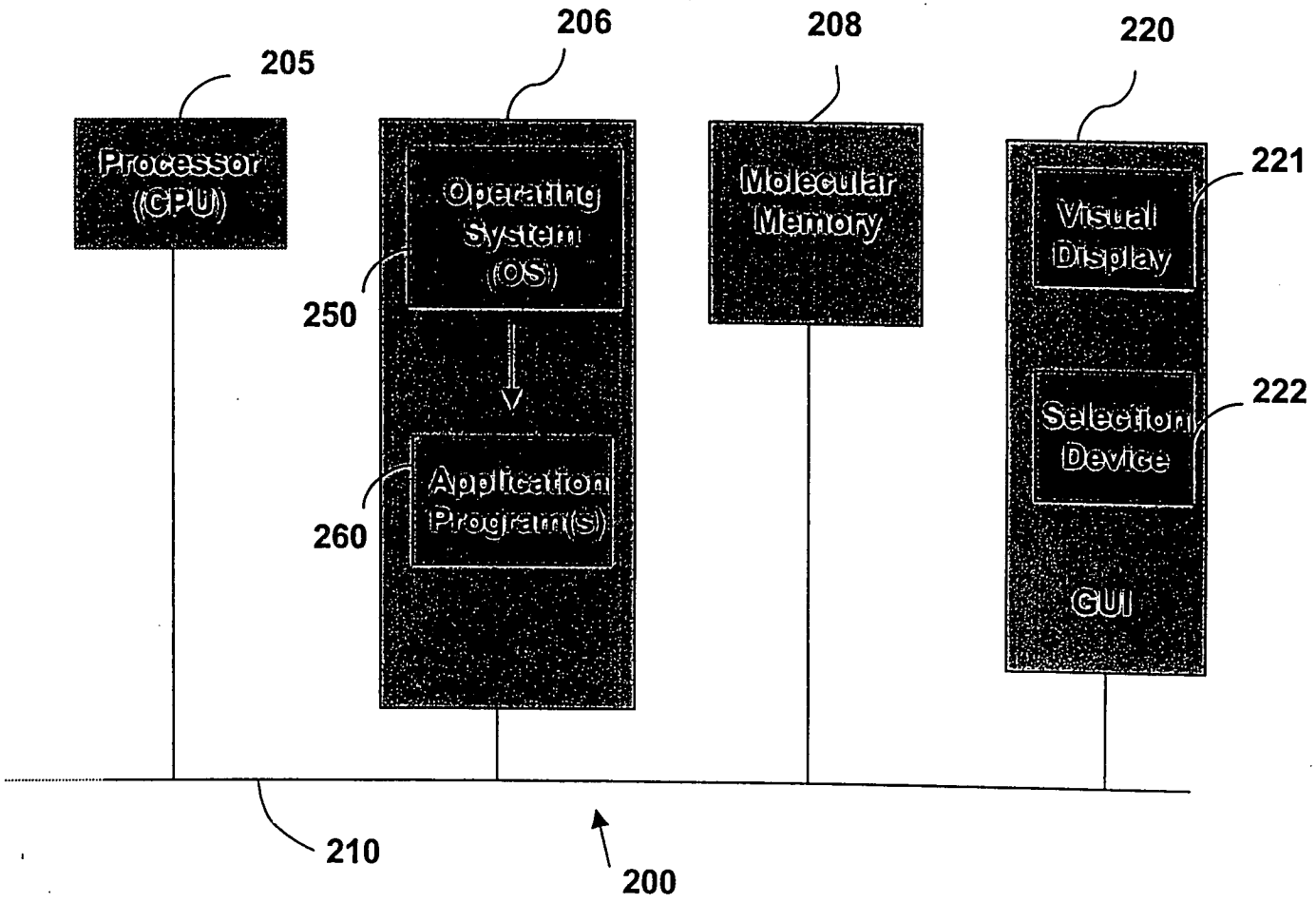

205
206
208
220
Processor (CPU)
Operating System (OS)
250
Application Program(s)
260
Molecular Memory
Visual Display
221
Selection Device
222
GUI
210
200

Fig. 13

Scheme 1.

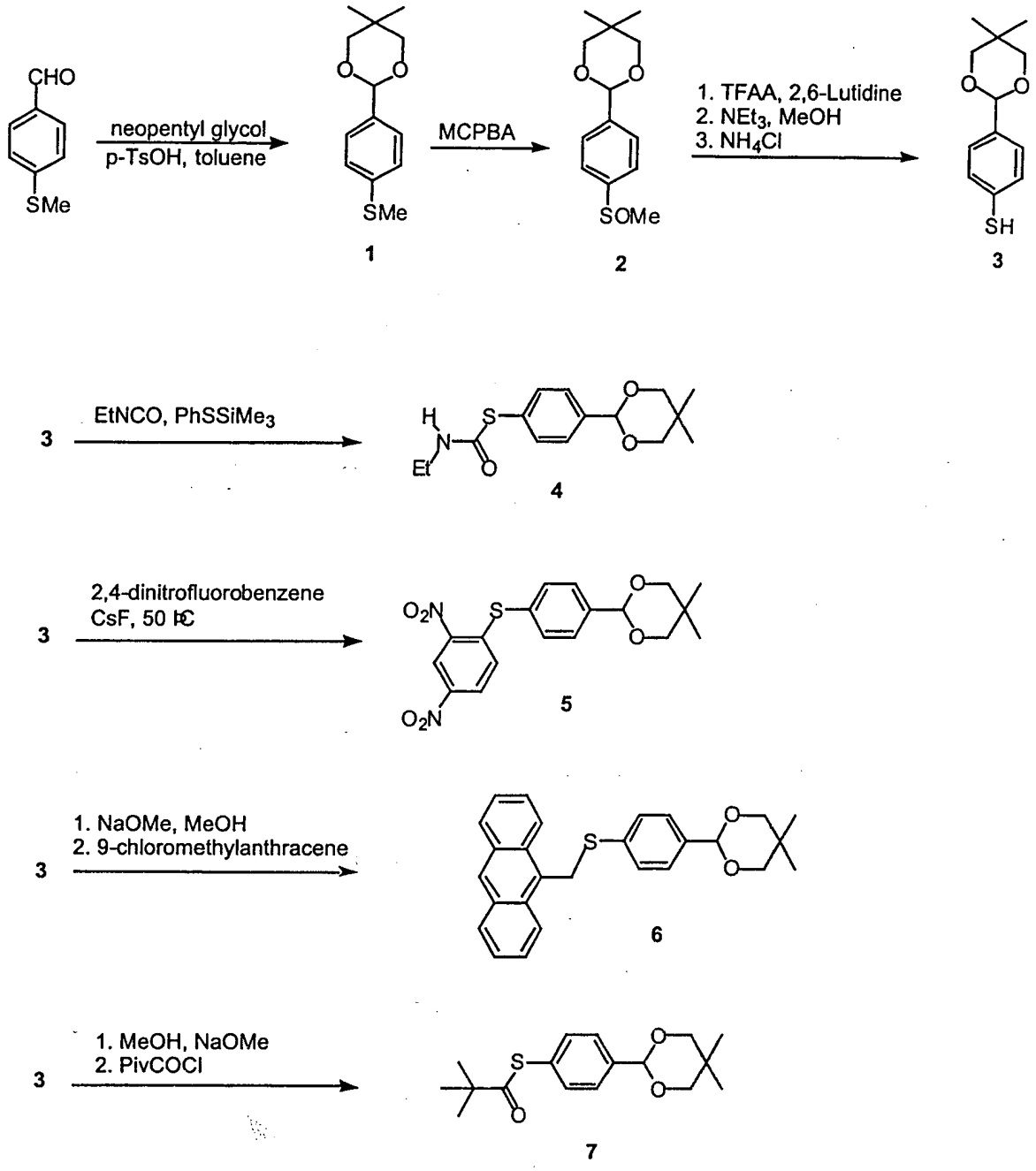


Fig. 14

Scheme 2.

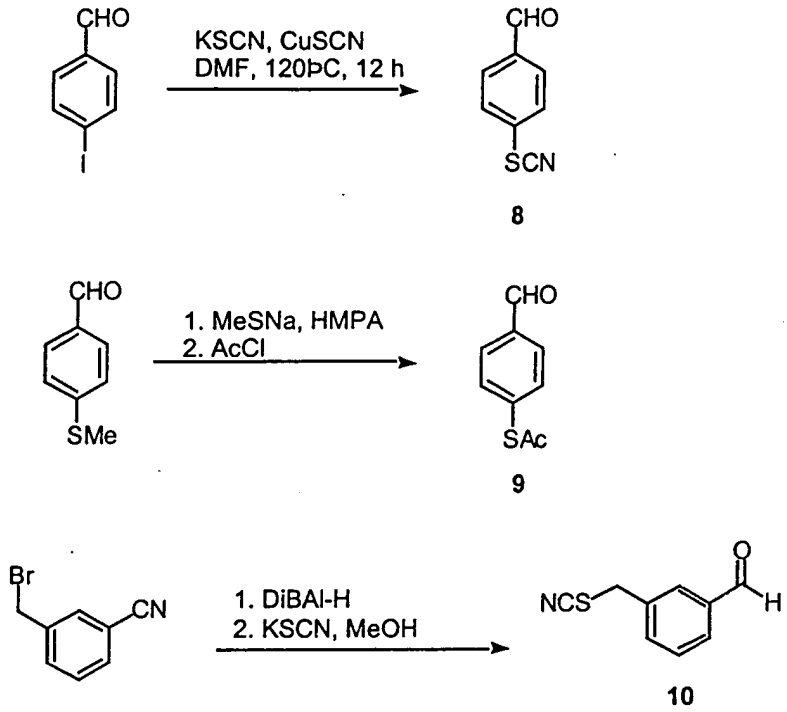
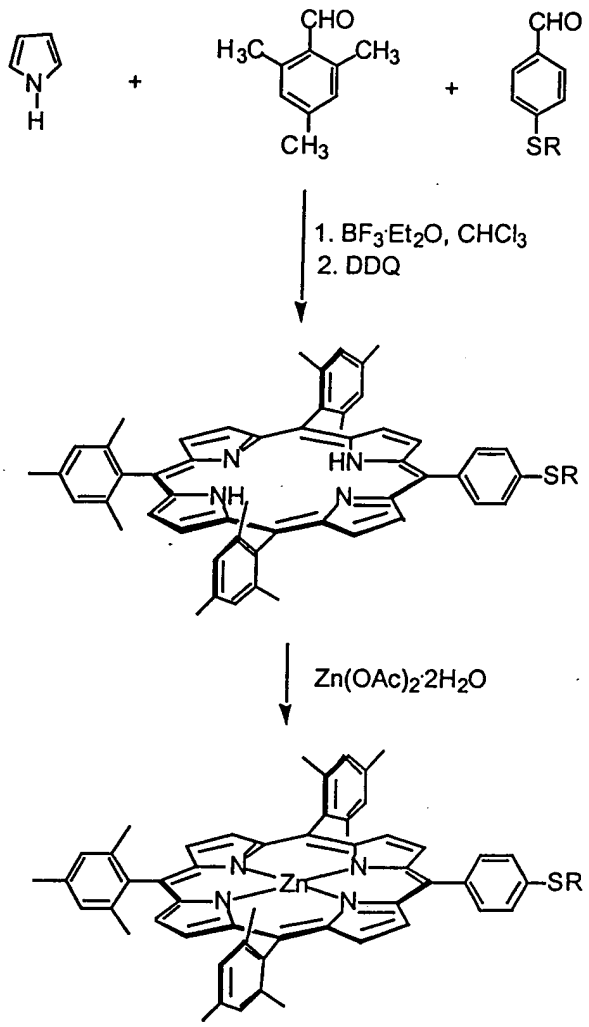


Fig. 15

Scheme 3.



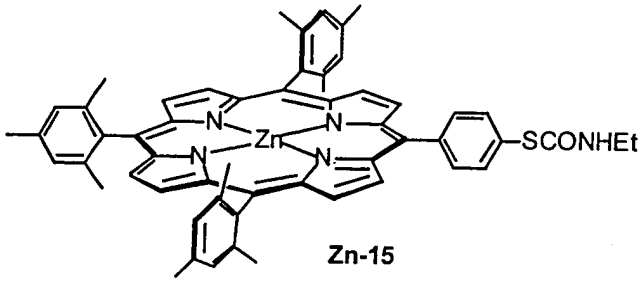
11. R = CONHEt
12 R = 2,4-dinitrophenyl
13. R = 9-anthrylmethyl
14. R = Piv
R = Me
9. R = Ac

15. R = CONHEt
16. R = 2,4-dinitrophenyl
17. R = 9-anthrylmethyl
18. R = Piv
19. R = Me
20. R = Ac

Zn-15. R = CONHEt
Zn-16. R = 2,4-dinitrophenyl
Zn-17. R = 9-anthrylmethyl
Zn-18. R = Piv
Zn-19. R = Me
Zn-20. R = Ac

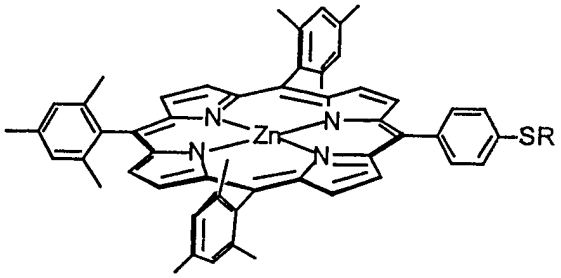
Fig. 16

Scheme 4.



Zn-15

1. NaOMe, MeOH, CH_2Cl_2
2. AcCl or HCl



Zn-20. R = Ac
Zn-21. R = H

Fig. 17

Scheme 5.

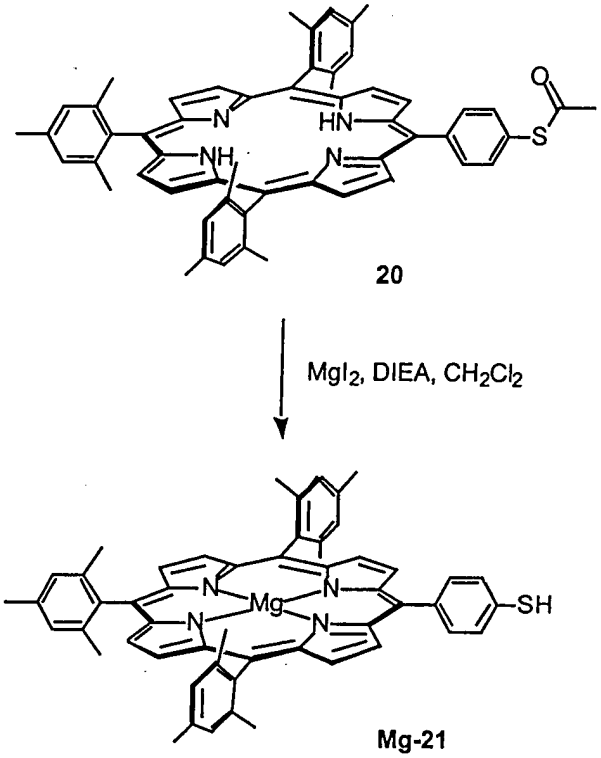
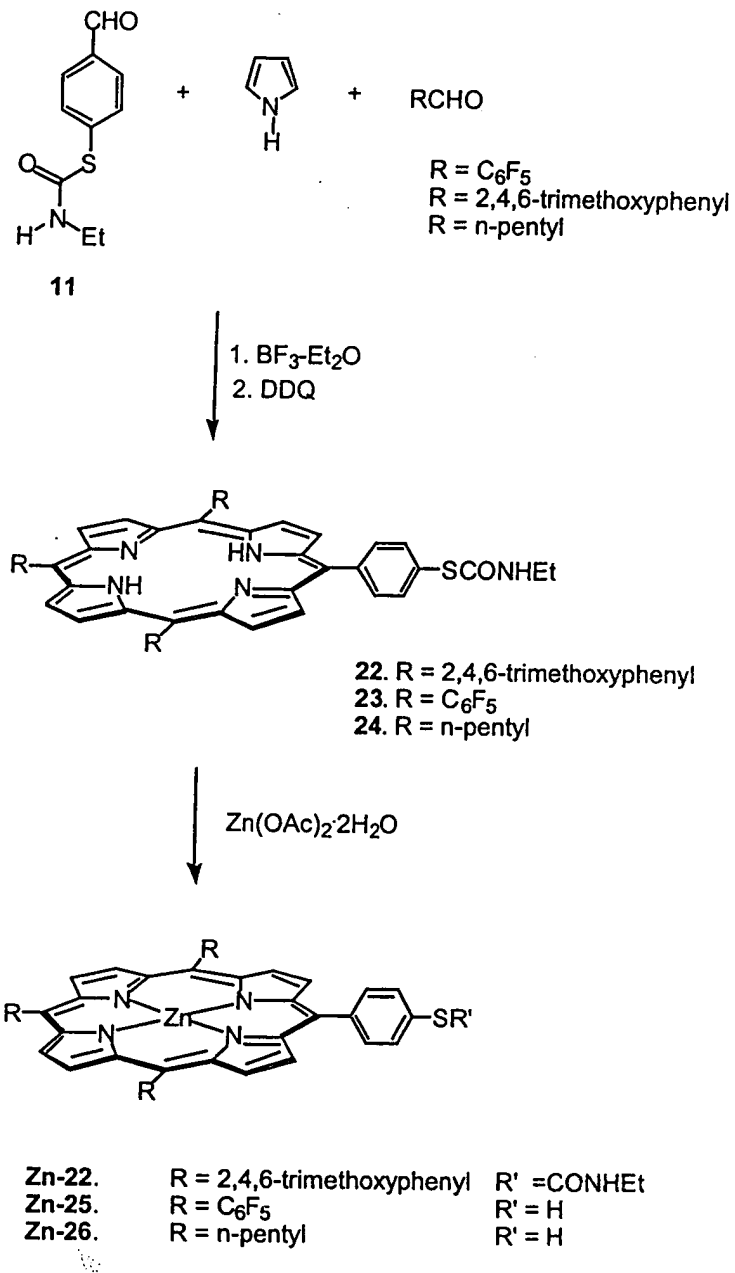


Fig. 18

Scheme 6.



Zn-22.	R = 2,4,6-trimethoxyphenyl	R' =CONHEt
Zn-25.	R = C_6F_5	R' = H
Zn-26.	R = n-pentyl	R' = H

Fig. 19

Scheme 7.

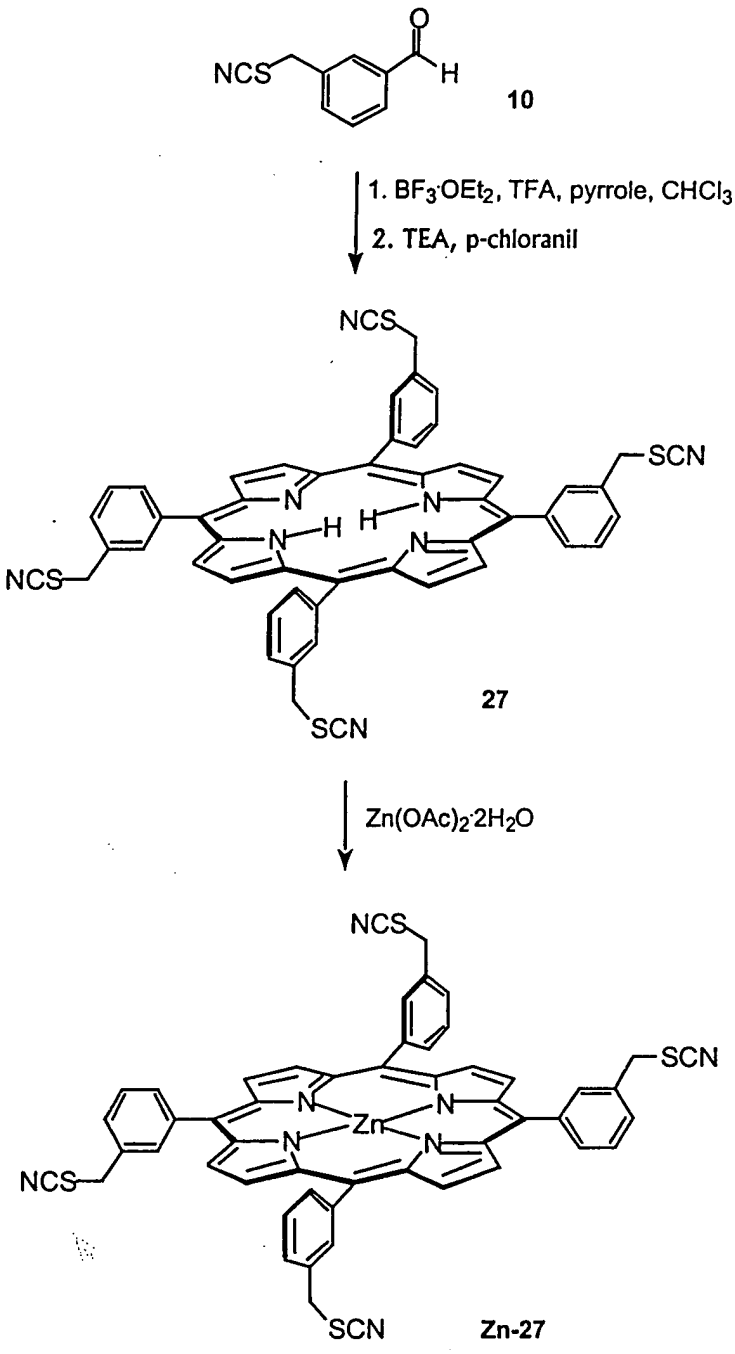


Fig. 20

Scheme 8.

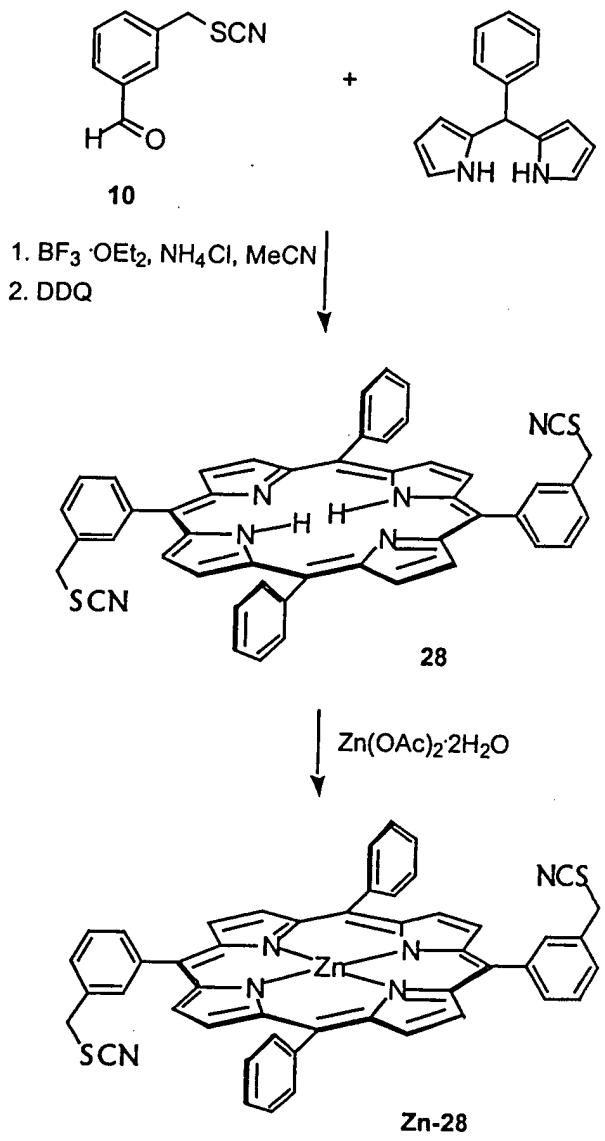


Fig. 21

Scheme 9.

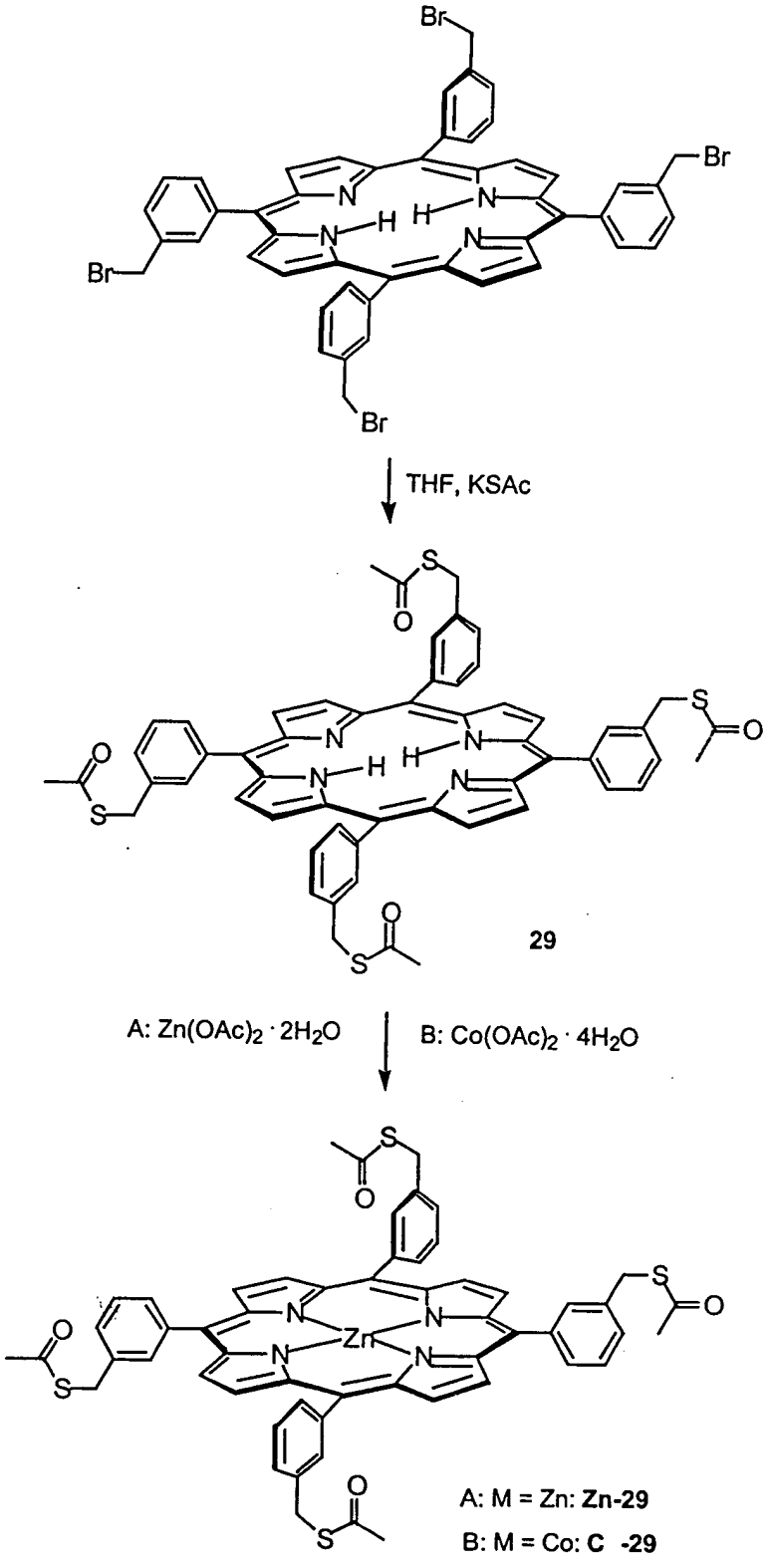


Fig. 22

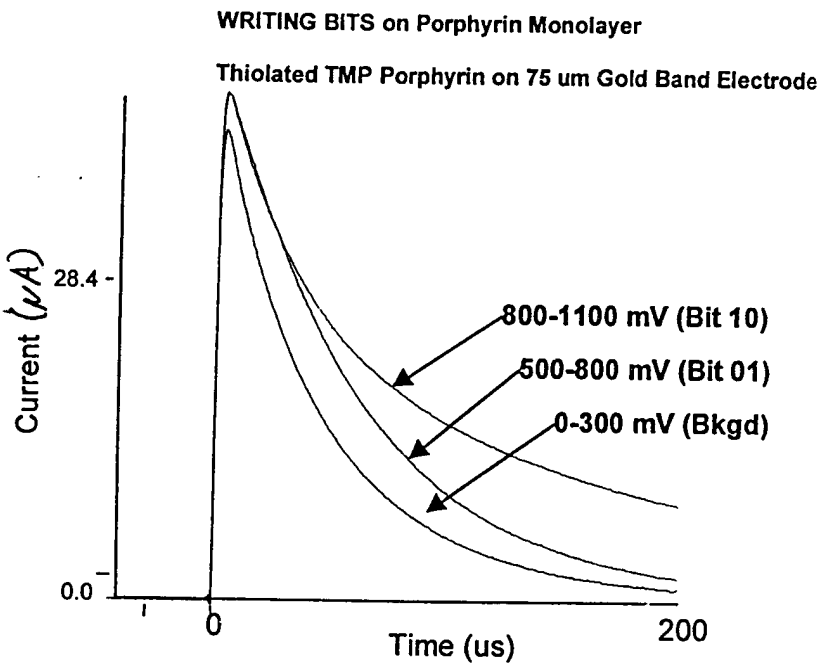

WRITING BITS on Porphyrin Monolayer
Thiolated TMP Porphyrin on 75 um Gold Band Electrode
Current (μA)
28.4
0.0
0
200
Time (us)
800-1100 mV (Bit 10)
500-800 mV (Bit 01)
0-300 mV (Bkgd)

Fig. 23

Background-Subtracted "READ" Current

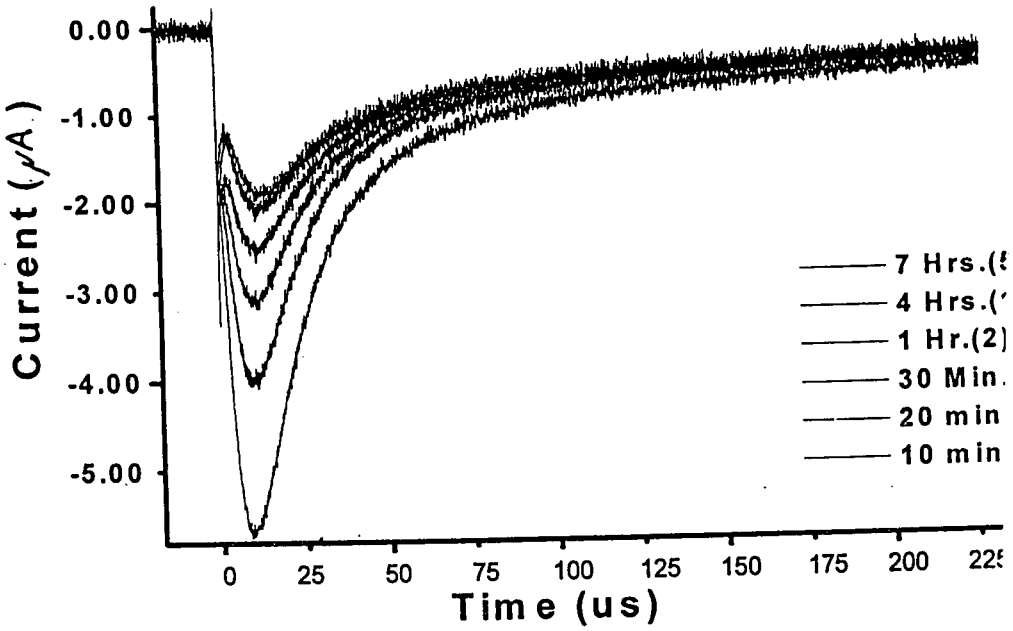


Fig. 24

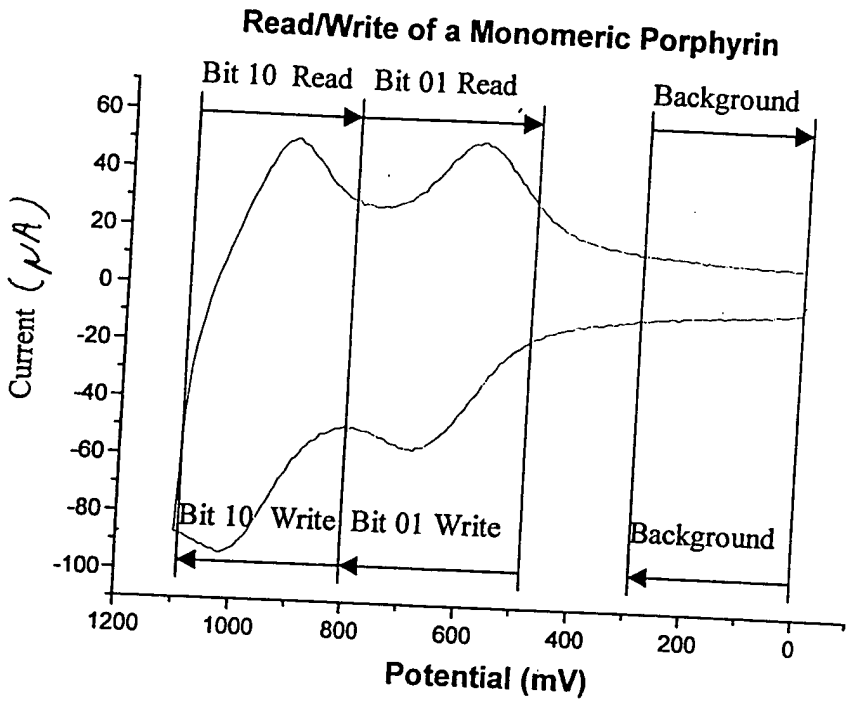

Read/Write of a Monomeric Porphyrin
Bit 10 Read
Bit 01 Read
Background
Bit 10 Write
Bit 01 Write
Background
Current (μA)
60
40
20
0
-20
-40
-60
-80
-100
1200
1000
800
600
400
200
0
Potential (mV)

Fig. 25